Loyola College in Maryland

Handbook for Graduate Students in Computing
The Loyola College in Maryland Graduate Catalogue contains university-wide policies and procedures that pertain to all graduate students. Students are responsible for the information in the general sections of the Catalogue as well as the parts that pertain to their specific program. This Handbook supplements the Catalogue and, in general, provides information not found in it. However, if the Handbook and Graduate Catalogue contain different information, the latter takes precedence.

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I. Technical Graduate Education at Loyola College

A. History

Loyola College is a member of the worldwide family of Jesuit universities, twenty eight of which are located in the US. Loyola, like its sister schools is noted for its academic excellence and its efforts to meet the needs of the community in which it is rooted. In that spirit, a Masters of Engineering Science (MES) program was established in 1978, under the leadership of Professor Bernard Weigman (now Professor Emeritus). Based in Hunt Valley, the MES program served engineers and offered three tracks: computer engineering, electrical engineering, and computer science. As computing matured, the need for professionals skilled in software design and implementation grew. The computer science track attracted the majority of students in the program.

In 2002, the MES program was restructured and the Computer Science Department became its departmental home. The Computer Science track was upgraded to an MS degree in Computer Science (MSCS) and a new program in the rapidly developing discipline of software engineering was inaugurated, the MS in Software Engineering (MSSE). The innovative MSSE program is the first of its kind in the area. In 2006, a concentration in Web Development was added to the Computer Science degree program. (See the Curriculum section below for details on the degree programs.)

B. The Computer Science Department

Computing education has a long history at Loyola. Growing out of the Physics and Engineering Departments, the Computer Science Department became a free-standing department in 1984. In 1990, the BS degree gained accreditation and today that degree continues to be accredited by the Computing Accreditation Commission (CAC) of the Accreditation Board for Engineering and Technology (ABET). (See Appendix A for the Computer Science Department Mission Statement.)

Today the Department has nine full-time faculty members with diverse research interest ranging from software testing to information retrieval. All full-time faculty members are committed to both graduate and undergraduate education and most teach each semester in the graduate program. They are aided by a corps of affiliate faculty, most of whom are engaged full-time in a technical profession. Many have made a long-term commitment to the program.

While full-time faculty members maintain offices at the Baltimore campus, they, like their affiliate colleagues encourage interaction with graduate students and welcome voice and email contact.

C. Faculty /Staff Directory

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Office</th>
<th>Voice Mail</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roger Eastman</td>
<td>Chair, CS Dept.</td>
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<tr>
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<tr>
<td>Michael Hinchey</td>
<td>Software Engineering Academic Coordinator</td>
<td>DS127b</td>
<td>410-617-2899</td>
<td><a href="mailto:mghinchey@loyola.edu">mghinchey@loyola.edu</a></td>
</tr>
</tbody>
</table>
## II. The Curriculum

Two graduate degree programs in computing are offered at Loyola College in Maryland: a Master of Science in Computer Science and a Master of Science in Software Engineering. In the Computer Science degree program, a special Web Development concentration is available. The degree programs in Computer Science and Software Engineering are offered at Loyola’s Graduate Centers in Columbia and Timonium. The Web Development concentration is available at the Columbia Campus only.

Designed to meet the diverse needs of computer science professionals, the Master of Science in Computer Science (MCS) degree offers a practitioner-oriented curriculum, which includes the study of advanced algorithms, computer networking, programming languages, operating systems, software engineering, and database systems. You may choose courses in object-oriented analysis, programming, and design as well as contemporary software engineering techniques. In addition to an Independent Study course, courses in graphics and human-computer interaction are among the advanced courses available to the interested and motivated student. The degree requirements include six graduate Computer Science (CS) core courses and five elective graduate CS courses. This degree program will accept qualified students with any undergraduate degree; a sequence of courses is available to prepare students for graduate study.

You may also pursue a Master of Science degree in Computer Science with a concentration in Web Development. Besides the study of advanced algorithms and database systems, the required core courses include the study of advanced HTML coding and design, web development with servlets and JavaServer Pages, Java design patterns, and XML technologies. You are free to choose five additional CS elective courses to complete the requirements for this degree. One of the electives may be an approved graduate business (GB)
course offered by the Sellinger School of Business and Management

Professionals who obtain the Master of Science in Software Engineering (MSSE) degree will gain advanced skills in project and personnel management, modern analysis and design methods, and contemporary quality assurance techniques. Students will have many opportunities to develop these skills in project-based courses and in their respective workplaces. The process of developing and maintaining large-scale software-based systems is complex. It involves detailed analysis, sophisticated techniques and the knowledge of how the system interacts with other components. Software engineers are the professionals charged with this task. Besides being familiar with the fundamentals of computer science, a software engineer must know the technical and management techniques required to construct and maintain such complex software systems. Just as in the case of the MSCS degree, six core graduate CS courses are required. However, of the five elective courses, at least one must be chosen from a list of approved graduate business (GB) courses offered by the Sellinger School of Business and Management.

A. The Master of Science in Computer Science

Degree Requirements

33 Credit Hours

Preparatory Courses

Preparatory courses must be completed or may be waived without replacement based on previous computing background. These courses do not count toward the 33 required credit hours.

CS 610 Discrete Mathematics and Algorithm Analysis
CS 620 Foundations of Computer Architecture
CS 622 Computer Networks
CS 630 Computing Fundamentals I
CS 631 Computing Fundamentals II

Required Core Courses (Computer Science)

CS 700 Advanced Data Structures and Algorithm Design
CS 701 Principles of Programming Languages
CS 702 Operating Systems
CS 730 TCP/IP Architecture
CS 762 Database Systems
CS 770 Software Engineering

Required Core Courses (Web Development)

CS700 Advanced Data Structures and Algorithm Design
CS710 Advanced HTML Coding and Design
CS712 Web Application Development with Servlets and JavaServer Pages
CS713 Java Design Patterns and Best Practices
CS714 XML Technologies and Applications
CS762 Database Systems
Electives (Computer Science)

Five courses at the CS710-level or above may be chosen. A maximum of three of these courses may be selected from those numbered CS771 or above. Unless otherwise noted, all CS700-level courses have CS600-level courses as prerequisites. CS600-level courses are not applicable toward the degree.

CS 710 Advanced HTML Coding and Design
CS 712 Web Application Development with Servlets and JavaServer Pages
CS 713 Java Design Patterns and Best Practices
CS 714 XML Technologies and Applications
CS 718 Graphics
CS 720 Internet and Web Programming
CS 722 Object-Oriented Programming
CS 732 Local Area Networks
CS 734 Wide Area Networks
CS 750 Special Topics
CS 751 Independent Study
CS 760 Advanced Operating Systems
CS 764 Network Security
CS 771 Engineering Systems Analysis
CS 772 Object-Oriented Analysis and Design
CS 773 Software System Specification
CS 774 Human-Computer Interaction
CS 780 Software Reliability and Testing
CS 790 Software Architecture and Integration
CS 791 Cost Estimation and Management
CS 792 Software Maintenance and Evolution

Electives (Web Development)

Five courses numbered CS701 or above may be chosen. A maximum of three of these courses may be selected from those numbered CS771 or above. One GB elective may also be chosen. Unless otherwise noted, all CS700-level courses have CS600-level courses as prerequisites. CS600-level courses are not applicable toward the degree.

CS 701 Principles of Programming Languages
CS 702 Operating Systems
CS 718 Graphics
CS 722 Object-Oriented Programming
CS 730 TCP/IP Architecture
CS 732 Local Area Networks
CS 734 Wide Area Networks
CS 750 Special Topics
CS 751 Independent Study
CS 760 Advanced Operating Systems
CS 764 Network Security
CS 770 Software Engineering
CS 771 Engineering Systems Analysis
CS 772 Object-Oriented Analysis and Design
CS 773 Software System Specification
CS 774 Human-Computer Interaction  
CS 780 Software Reliability and Testing  
CS 790 Software Architecture and Integration  
CS 791 Cost Estimation and Management  
CS 792 Software Maintenance and Evolution  
GB 701 Operations and Project Management  

For course descriptions, see Appendix B. For flowcharts of the MSCS requirements, see Appendix C and Appendix D.
B. The Master of Science in Software Engineering

**Degree Requirements**

33 Credit Hours

*It is assumed that all students entering the Software Engineering program have completed the* preparatory courses listed in the Computer Science requirements. Also, the candidate should have completed the equivalent of CS700 Advanced Data Structures and Algorithm Design, CS701 Principles of Programming Languages and CS702 Operating Systems. Depending on the candidate’s background, these courses may be waived without replacement. In any case, these courses do not count toward the 33 required credit hours.

**Required Core Courses**

CS 762 Database Systems
CS 770 Software Engineering
CS 773 Software System Specification
CS 774 Human-Computer Interaction
CS 780 Software Reliability and Testing
CS 790 Software Architecture and Integration

**Software Engineering Electives**

Two Courses at the CS 750-level or above
At least one approved Sellinger School of Business and Management course
Any combination of two courses chosen from
  a) CS 710-level or above
  b) approved Sellinger School of Business and Management course

CS 710 Advanced HTML Coding and Design
CS 712 Web Application Development with Servlets and JavaServer Pages
CS 713 Java Design Patterns and Best Practices
CS 714 XML Technologies and Applications
CS 718 Graphics
CS 720 Internet and Web Programming
CS 722 Object-Oriented Programming
CS 730 TCP/IP Architecture
CS 732 Local Area Networks
CS 734 Wide Area Networks
CS 750 Special Topics
CS 751 Independent Study
CS 760 Advanced Operating Systems
CS 764 Network Security
CS 771 Engineering Systems Analysis
CS 772 Object-Oriented Analysis and Design
CS 791 Cost Estimation and Management
CS 792 Software Maintenance and Evolution
Approved Sellinger School of Business and Management Courses

Other courses may be elected with the approval of the graduate program directors of computing and business.

GB 700 Ethics and Social Responsibility
GB 701 Operations and Project Management
GB 705 Leadership and Management
GB 754 Information Systems Security
GB 895 Quality Management

For course descriptions, see Appendix B. For a flowchart of the MSSE requirements, see Appendix E.

III. Registration for Courses

A. New students

The Loyola Graduate Programs in Computing (MCS and MSSE) welcome students who are graduates of accredited four-year institutions. A decision on acceptance is made by the Director of the Programs in Computing in collaboration with the Computer Science Department Chair and the three Academic Coordinators. The prospective student must submit an official transcript of all college work and confer with the appropriate Academic Coordinator for proper placement in the program. Students seeking the MCS who have little or no formal experience with computing are expected to complete the sequence of preparatory courses. Students seeking an MSSE are expected to have a high degree of understanding of computer science, equivalent to an undergraduate major in computer science.

B. Returning Students

Students are encouraged to discuss course selections each semester with their advisor prior to completing registration. The advisor’s signature must be obtained on all registration forms; other faculty members may not sign forms for the advisor. If students are registering by mail or online, the registration form will automatically be forwarded to the Computer Science Department for the necessary signatures. If students are registering in person, either during the mail-in period or during in-person registration day, they must obtain their advisor’s signature on the registration form prior to submitting it to the Records Office. Students may register only for courses for which they have successfully completed all prerequisites.

Students wishing to drop a course prior to the first class meeting will receive full tuition refund, less any registration or other fees. After the first class meeting, partial tuition refunds are given according to the policy stated in the Graduate Catalogue. Students who wish to withdraw from a course during the semester should discuss this with the instructor as well as their advisor. The course withdrawal policy is outlined in the Graduate Catalogue.

C. Exemption from Courses/Transfer of Credits

Students who are accepted to one of the Master of Science programs may be permitted to transfer up to six credits toward their degree for graduate courses taken at other institutions. These courses must have been completed in an accredited school’s graduate program within five years of the date of admission to Loyola College, and the student must have received a grade of “B” or higher.
Certain preparatory courses may be waived for students if they have completed equivalent course work or can demonstrate their proficiency in the subject matter. Similarly, students may be granted an exemption for certain courses required for the degree program if they have completed similar coursework at another institution. However, any student who is granted exemption from a required (non-preparatory) course must substitute an alternative course in order to fulfill the total number of credits required for their program. Decisions on exemptions and waivers are made in writing by the Director of Graduate Programs in Computing or the Academic Coordinator of the appropriate MS program.

IV. Academic Standards

A student who has reason to question the accuracy of a grade should refer to the Graduate Catalogue for information about the process for appealing a grade. A student must maintain minimum academic standards. Failure to do so will result in dismissal from the program. Information about academic standards, probation, and dismissal can be found in the Graduate Catalogue.

V. Academic Integrity

As a Jesuit, Catholic university, integrity and honesty are integral components of Loyola’s core values. This commitment to integrity and honesty is manifested in an atmosphere of open, civil discourse and careful, respectful listening where freedom of thought and expression are valued and protected. The College also supports honesty and integrity by striving in various ways to foster respect for oneself and one’s own work, as well as respect for others, their work, and their basic human rights.

Students are expected to conduct themselves honestly on all academic assignments. College-wide information about academic integrity as well as procedures for addressing alleged violations can be found in the Graduate Catalogue.

VI. Standards of Conduct

As a Catholic university in the Jesuit tradition, Loyola strives to nurture the formation of “men and women for others” and to provide an atmosphere of “cura personalis,” care for the whole person, so that each individual can realize his or her full potential. All members of the Loyola community have the right to be treated with courtesy and respect. In this spirit, Loyola espouses the highest ethical standards and expects students, faculty, administrators, and staff to conduct themselves in a manner that upholds these principles. Here are several general areas in which these Standards of Conduct apply: official College-wide policies, legal regulations, and generally acceptable standards of personal conduct. College-wide information about standards of conduct as well as procedures for addressing alleged violations can be found in the Graduate Catalogue.

In addition to College-wide standards of conduct, the Computer Science profession has a professional code of ethics to which all students are expected to adhere. Information about this ethical code as well as procedures for addressing alleged violations appear below. Students are responsible for this information as well as the College-wide information contained in the Graduate Catalogue.

The Loyola Computer Science Department recognizes the rights of students and faculty to be treated with courtesy and respect. It is expected that all interactions among students, faculty and staff will reflect the highest standards of the scholarly community and the profession. The Department requires all students, faculty and staff to conduct themselves in accordance with the Association for Computing Machinery’s Code of Ethics, which outlines an ethical code for computing professionals. The ethical implications of technology and, more particularly, computing are important and are recognized as an integral part of technical study at Loyola.
Student Complaints about Faculty Conduct

Students who have complaints about the professional or ethical conduct of faculty should handle their complaint through appropriate College channels. Student questions about what the appropriate channels are in a particular case can be addressed to a trusted faculty advisor, a Department Chair, or Human Resources. For example, complaints about the content or pedagogy of a particular class should be addressed first to the instructor and then to the Department Chair; if the Chair is the instructor, the complaint can be addressed to the appropriate academic Dean. Complaints about grading should follow the Grade Appeal process outlined in the Graduate Catalogue. Complaints that a faculty member has violated some other professional or ethical standards should be addressed to the Chair or, if the Chair is the object of the complaint, to the appropriate Dean. Complaints about discrimination or harassment should use the procedures outlined in the College's Harassment and Discrimination Policy and Procedures.

VII. Professional Organizations

All students are encouraged to become Student Affiliate or Associate Members of the Association for Computing Machinery (ACM). The Computer Science Department sponsors a student chapter of Upsilon Pi Epsilon, a national computing honor society. Graduate students with an outstanding record of academic achievement are invited annually to be inducted into this society.
Appendix A: Computer Science Department Mission Statement

Computer science is a dynamic, vibrant field that, despite its relative youth in the academic community, provides students both a vigorous set of intellectual principles as well as excellent opportunities for employment. It is easy to see the broad and rapid spread of computer technology throughout business and academia creating the need for well-educated professionals to staff and lead this revolution. A more important and lasting revolution may be the spread of computing concepts as businesses go to e-commerce models, biology becomes computational, psychology is enriched with a cognitive, computational branch, philosophy comes to terms with algorithmic limits of knowledge, physics grapples with information theory and complexity, linguistics constructs theories of language acquisition on computational theorems, artists produce art by heuristic principles, communication goes digital, and almost every other discipline collaborates with a computer scientist on a cutting edge project.

The mission of the Computer Science Department is to educate the next generation of computer professionals and to participate in the multidisciplinary education of all students.

The Computer Science Department Mission

To educate the next generation of computer professionals who will

• Embody the best ideals of a liberal Jesuit education as knowledgeable, caring, ethical, well-spoken men and women with critical and reasoned judgment.
• Be proficient in computer languages, development tools and hardware.
• Be able to author high quality solutions to real problems in today’s technology using well-established principles of engineering, and be able to evaluate those solutions by rigorous means.
• Understand well the fundamental principles of computer science theory in order to become lifelong learners who can build and understand tomorrow’s technology.
• Be both effective leaders and team players who can work well with others.
• Be effective at written and oral communication, be able to read and write technical papers and reports and present results.

To insure that all students on campus have opportunities to

• Explore computing to gain an understanding of fundamental computing principles and computing applications important to their chosen discipline.
• Pursue in-depth interdisciplinary studies to master the application of computing in their field of study.

The Computer Science Department Principles and Values

In carrying out its mission, the Computer Science Department uses these principles of pedagogy and ethical values to guide their work with students.

• The department wishes to foster a community of scholars who work together with students and faculty on challenging problems. This is to allow students to identify themselves as professionals by working on real problems in a setting that accurately reflects their future career. The department wishes to design its facilities and equipment to meet these goals by locating faculty offices near student laboratories and integrating laboratory work into the curriculum when appropriate.

• The department recognizes that their students are a diverse group of individuals, each with their own talents, skills, motivations and career objectives. The department promises to do its best for each student,
challenging the stronger students and providing a caring, supportive environment for all. For those students interested in research and graduate school, the department maintains an undergraduate research program with opportunities to work closely with faculty on real problems. For those students interested in professional practice, the department supports working laboratories where students maintain computers and networks, produce web pages and applications, perform technical service work for others and engage in useful professional activities.

- The department follows the high standards established by national accreditation boards in managing its BS degree program. Even though there is no accreditation for graduate computing programs, the high standards in the undergraduate program permeates the graduate programs in computing as well.
- The department encourages students and faculty to undertake tangible projects that benefit the disadvantaged.
- The department recognizes that computer science is an extremely rapidly changing field which must be taught by those who are currently active in the field. To this end, the department provides strong support for faculty scholarship and research in order to maintain the skills and knowledge required to continue teaching in such a dynamic discipline.
Appendix B: Course Descriptions

CS 610 Discrete Mathematics and Algorithm Analysis - 3 credits
A survey of mathematical topics common to many areas of computer science. Topics include logic and proof techniques, sequences and summations, set theory and combinatorics, probability, recurrence relations and asymptotic growth of functions, graph theory, finite-state machines, and Turing machines.

CS 620 Foundations of Computer Architecture – 3 credits
Covers basic concepts of digital logic including logic gates, flip-flops, registers and counters. Discusses elements of design including Karnaugh maps and sequential theory. A glimpse of different microcomputer systems. Compares assembly language techniques for different microprocessors.

CS 622 Computer Networks – 3 credits
Prerequisite: CS 620. The course begins with an overview of data and computer communications including an introduction to the TCP/IP protocol architecture. Necessary areas of mathematics, science, and engineering are presented in preparation for a review of the underlying technology of networking. The area of data communication is surveyed including data transmission, transmission media, data encoding, data communication interface, data link control, and multiplexing. Wide area networking, including both circuit-switched and packet-switched implementations, is considered. Local area networking technology and implementations are reviewed. The course concludes with a look at Internet protocols, transmission control protocols, and security issues.

CS 630 Computing Fundamentals I – 3 credits
An introduction to the basic concepts of computer organization and programming. Algorithms are defined and used. Numeric and character manipulation is carried out. File handling, recursive functions, and elementary data structures are studied. Computer use required.

CS 631 Computing Fundamentals II – 3 credits
Prerequisite: CS 630. Intermediate programming in C/C++ emphasizing structured methodologies for development, debugging, testing, and verification of programs. Topics include recursion; pointers; dynamic memory allocation; and elementary data structures such as stacks, queues, linked lists and binary trees.

CS 700 Advanced Data Structures and Algorithm Design – 3 credits
Prerequisites: CS 610, CS 631. A study of the design and analysis of efficient computer algorithms and data structures. Topics include recurrences, sorting, order statistics, dynamic programming, graph algorithms, and NP-completeness. May include additional topics from the current literature.

CS 710 Advanced HTML Coding and Design – 3 credits
Prerequisite: CS 631. This course concentrates on HTML coding from beginning to advanced concepts as well as Cascading Style Sheets (CSS) and JavaScript. Covers Web page layout techniques and graphics concepts using current, standard commercial tools. Prior knowledge of HTML, CSS, and JavaScript is helpful but not required.

CS 701 Principles of Programming Languages – 3 credits
Prerequisite: CS 700. Concepts and structures governing the design and implementation of modern programming languages. Run-time representations of traditional block structured languages, typing systems, abstraction and procedure mechanisms, and storage management. Special emphasis on object-oriented and functional languages, their type systems, and operational and denotational semantics.

CS 702 Operating Systems – 3 credits
Prerequisites: CS 620, CS 700. Considers processes, process synchronization and mutual exclusion, and techniques for memory allocation, scheduling, and disk management. Surveys current computer operating systems and discusses research in distributed operating systems.

CS 710 Advanced HTML Coding and Design – 3 credits
Prerequisite: CS 631. This course concentrates on HTML coding from beginning to advanced concepts as well as Cascading Style Sheets (CSS) and JavaScript. Covers Web page layout techniques and graphics concepts using current, standard commercial tools. Prior knowledge of HTML, CSS, and JavaScript is helpful but not required.

CS 712 Web Application Development with Servlets and JavaServer Pages – 3 credits
Prerequisite: CS700. This project-oriented course delves into techniques for developing server-side programs for Web sites, electronic commerce, Web-enabled enterprise computing, and other applications that require WWW access to server-based resources. Attention will be paid to methods for making server-side applications efficient, maintainable, and flexible. Topics include handling HTTP request information, generating HTTP response data, processing cookies, tracking sessions, server-side security, designing custom JSP tag libraries, and some common "real world" design patterns used in Web development.

CS 713 Java Design Patterns and Best Practices - 3 credits
Prerequisite: CS 700. Provides real-world Java best practices along with concepts underlying these best practices. Examines core design patterns used in everyday Java development including discussion of why and when design patterns are useful as well as how specific design patterns support best practices. Assigned projects will exercise the application of sound software design and best practices.

CS 714 XML Technologies and Applications – 3 credits
Prerequisite: CS 712. This project-oriented course introduces the student to XML and XML-related technologies. The course will cover XML itself, DTD, XML Schema, Namespaces, XSLT, XPath, SAX, DOM, and JAXP. It will also briefly introduce basics of CSS and HTML. The course will likewise cover JAXB, Apache Digester. The student will be introduced to Web Services (RMI, WSDL, SOAP, JAX-RPC, etc.) within the J2EE as well as standalone client environments. Projects will reinforce the concepts discussed in class, requiring the student to use these technologies to solve similar-to-real-world problems, including developing and deploying J2EE-compliant Web Services. The Java programming language will be utilized.

CS 718 Graphics – 3 credits
Prerequisite: CS 700. A comprehensive analysis of the techniques and algorithms used to develop graphical images using computer generated data. Covers the mathematical concepts required to produce two- and three-dimensional text and graphics on raster and vector displays. Examines and evaluates hardware and software design considerations relative to current display technology. Explores techniques for three-dimensional photorealistic graphics, as well as advanced methods in object modeling and animation. Emphasis on the algorithms and mathematical principles that underpin programming techniques. Includes ray tracing, hidden surface elimination, radiosity, physics-based modeling for animation, and other topics as possible.

CS 720 Internet and Web Programming – 3 credits
Prerequisite: CS 701. Use of API’s for elements such as menus, accelerators, icons, bitmaps, and dialog boxes; timer basics; multitasking and multithreading; multiple-document interface; dynamic-link libraries; client-side technologies and dynamic object models; server-side technologies; configuration and administration, forms processing with CGI programs and Servlets; and special topics which may include web database management, JSP, XML, and multi-tiered architectures.

CS 722 Object-Oriented Programming – 3 credits
Prerequisite: CS 701. Surveys major concepts in object-oriented analysis, design, and programming such as
encapsulation, information hiding, inheritance, and polymorphism. Covers how these ideas are implemented in modern programming languages such as Java, C#, Python, Smalltalk or C++. Students are assigned programming projects using an object oriented language to enhance their understanding of the concepts of Object-Oriented Programming.

**CS 730 TCP/IP Architecture – 3 credits**  
Prerequisite: CS 622, CS 702. Students develop the following TCP/IP Layers: Link, Network, Transport, and Application. Use of diagnostic tools to watch constructed protocols in action.

**CS 732 Local Area Networks – 3 credits**  
Prerequisite: CS 730. Fundamentals of LAN Architectures. Topics include OSI layers 0, 1, and 2; 10BASE-5, 10BASE-2, 10BASE-T, 100BASE-T, TOKEN RING and FDDI. Students develop LAN strategies through case studies, ranging from actual implementation to business models.

**CS 734 Wide Area Networks – 3 credits**  
Prerequisite: CS 730. A survey of wide area networks which includes traditional telephone networks, frame relay networks and ATM, and asynchronous transfer networks, switched, fast, and gigabit ethernet. In addition, dynamic routing protocols are studied and applied through laboratory experiments.

**CS 750 Special Topics in Computer Science or Software Engineering – 3 credits**  
An on-demand course for a current topic.

**CS 751 Independent Study – 3 credits**  
Students must submit a written proposal to a member of the faculty of the computer science program prior to the last day of class registration. Proposed topics, which are normally discussed in advance with the professor, should permit study and/or laboratory work in considerable depth beyond the scope of a course offered in the curriculum.

**CS 760 Advanced Operating Systems - 3 credits**  
Prerequisite: CS 702. An in-depth inspection of the UNIX operating system internals via the C programming language. Topics include system calls and their internals, process implementation, communication, and management; file system implementation and management; device management; and networking.

**CS 762 Database Systems – 3 credits**  
Prerequisite: CS 631. Discusses major database organizations with emphasis on the relational approach. Topics include physical storage; design tools including entity-relationship modeling and normalization techniques; query processing including formal languages, SQL, QBE, and optimization; transaction modeling; concurrency issues; current trends in DBMS. Includes laboratory experiences with the design and use of DBMS.

**CS 764 Network Security – 3 credits**  
Prerequisite: CS 730. The class will focus on practical applications such as firewalls, intrusion detection, virus prevention, and security settings for Windows and Linux. The class will also cover the basics of cryptography as well as security protocols such as SSL, IPsec, and Kerberos.

**CS 770 Software Engineering – 3 credits**  
Prerequisite: CS 700. Covers the field of software engineering: planning, product definition, design, programming, testing and implementation. Covers topics of structured design and programming in depth. Software systems design and program architecture-alternative system types. Module design, coding and
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<td>CS 771</td>
<td>Engineering Systems Analysis</td>
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<tr>
<td>Prerequisite: CS 770. Emphasizes engineering systems and the modern techniques of generating alternatives, evaluation and selection criteria including resource scheduling, decision theory and optimization methods.</td>
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<tr>
<td>Prerequisite: CS 631. Presents the concepts and techniques necessary to effectively use system requirements captured through use cases to drive the development of a design model. Students use Unified Modeling Language (UML) to represent fundamental object-oriented analysis and design concepts including architecture, objects, classes, components, stereotypes, relationships, and all supporting diagrams.</td>
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<tbody>
<tr>
<td>CS 773</td>
<td>Software System Specification</td>
<td>3</td>
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<tr>
<td>Prerequisite: CS 770. Studies the following as they relate to the construction of large-scale software systems: Axiomatics, Algebraic Specification Languages, Functional Correctness, Predicate Transformers, Denotational Semantics, and Communicating Sequential Processes. Emphasis is on the rigor required to design and build critical systems.</td>
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<tr>
<td>CS 774</td>
<td>Human-Computer Interaction</td>
<td>3</td>
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<tr>
<td>Prerequisite: CS 770. Human factors issues in the development of software, the use of database systems, and the design of interactive systems. Issues include: programming and command languages; menus, forms, and direct manipulation; graphical user interfaces, computer-supported cooperative work, information search and visualization; input/output devices; and display design.</td>
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<tr>
<td>CS 780</td>
<td>Software Reliability and Testing</td>
<td>3</td>
</tr>
<tr>
<td>Prerequisite: CS 770. Topics covered include reliability: reliability concepts and design techniques, management techniques, reliability models, issues of software security; testing: formal and informal methods; program analysis: dynamic analysis, static analysis, data flow analysis; selection of test cases; program instrumentation; mutation analysis; and symbolic execution.</td>
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<tr>
<td>CS 790</td>
<td>Software Architecture and Integration</td>
<td>3</td>
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<tr>
<td>Prerequisite: CS 770. Topics include the organization of a software system, the selection of the structural elements and their interfaces and behavior as specified in the collaboration among those elements, the composition of these elements into progressively larger subsystems, the architectural style that guides this organization, these elements and their interfaces, their collaborations, and their composition.</td>
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<tr>
<td>CS 791</td>
<td>Cost Estimation and Management</td>
<td>3</td>
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<tr>
<td>Prerequisite: CS 770. Covers both traditional and state-of-the-art methods identifying advantages and disadvantages of each and the underlying aspects in preparing cost estimates. Topics: estimation, risk analysis, scheduling, software quality assurance, software configuration management planning and execution.</td>
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<tbody>
<tr>
<td>CS 792</td>
<td>Software Maintenance and Evolution</td>
<td>3</td>
</tr>
<tr>
<td>Prerequisite: CS 770. Software maintenance, also known as software evolution, is the implementation of consistent changes to an existing system. This difficult task is compounded both by the pressing business constraints which lead to the required change and the inherent difficulty of safely modifying complex systems. This class will examine both the process under which software is changed (e.g., configuration control) and modern techniques for reducing the engineer's effort when making changes (e.g., comprehension strategies,</td>
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consistent change principles, ripple analysis, and regression test effort).
Appendix C. MS in Computer Science
Degree = 11 courses = 6 required
+ 5 electives
No more than 3 electives numbered 771 and above may be selected.

Note: Not all courses are shown.
Appendix D. MS in CS (Web Development Concentration)
Degree = 11 courses = 6 required
+ 5 electives
1 Business Course and no more than 3 electives numbered 771 and above may be selected.

Note: Not all courses are shown.
Appendix E. MS in Software Engineering
Degree = 11 courses = 6 required
+ 5 electives
(>=1 but <=3 Business Courses)

Note: Not all courses are shown.